Scleractinian Corals from the Norfolk Island Cable

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INTRODUCTION

Among the modern corals in the collections of the Auckland Museum are a suite of specimens collected by the late Mr. W. Foster from the Norfolk Island-New Zealand cable during its repair in 1932. Seven specimens of Scleractinia were taken alive from the cable together with a number of large reteporid bryozoans, stylasterids and alcyonarian corals. The scleractinian corals are of some interest because of the association of species, certain characters of their morphology, and the significant extensions of geographic ranges indicated by the presence of some of the species.

Of some considerable interest was the possibility of deriving the growth rates of the specimens taken from the cables. In the absence of data otherwise obtained, growth rates of the deeper-water corals have generally been deduced through study of specimens found adhering to objects of a known age, such as cables or buoy chains. Data obtained in this fashion can represent only the minimum growth rate, assuming that the larvae settled on the object immediately upon its immersion. The shorter the period of immersion of the substrate, the more valuable the data. With some anticipation the maintenance records of the cable in question were sought. Unfortunately, from the stand-point of growth rate studies, its service had been quite satisfactory and its history is therefore a long one. Only three previous studies of corals attached to cables are known to me, two of which are from the Atlantic, one from the Mediterranean.

A great amount of information may be obtained from a study of cable faunas. Their collection and preservation is to be encouraged. The specimens described here were collected by the late Mr. W. Foster, Engineer of the New Zealand Post Office, a conscientious collector, who greatly enriched the collections of the museums of New Zealand. I am grateful to Dr. A. W. B. Powell for permission to study this interesting suite of corals and for the kind hospitality extended to me at the Auckland Museum. Information concerning the cable history was supplied by the Engineer in Chief, New Zealand Post Office, Wellington, Mr. George Bull, through the kind offices of Dr. R. A. Falla, Dominion Museum. Photographs of the specimens were made by Mr. S. N. Beatus, New Zealand Geological Survey. This study was completed during the tenure of a Fulbright Research Grant under the auspices of the New Zealand Geological Survey.

GROWTH RATES

Growth rate data derived from studies of cable faunas are not common literature; three previous studies are known to me and are summarized in table 2. The significant feature in common to all of these is the relatively short time that each of the cables had been in

service, and the great depth of water from which the specimens had been recovered. Unfortunately, the information derivable from the Norfolk Island cables is not of comparable significance. According to the records supplied by Mr. George Bull, the section of cable under consideration, 15.655 nautical miles from Norfolk Island (position approximately 29° 20′ 00″ S., 168° 07′ 35″ E.) was lifted August 19, 1932 and 1.63 miles were cut out. Of the section cut out, 1.32 miles had been laid in 1901, the remaining 0.31 miles laid in 1914. Under the assumption that the specimens are as old as the cable, they have alternative maxinum ages of 17 or 30 years. Growth rates derived from these alternatives are given in table 1.

Table 1

Growth Rates of Scleractinian Corals from Norfolk Island Cable.

Species	Assuming Cable Age of 17 Years			Assuming Cable Age of 30 Years		
	Height[1] (mm/yr)	Weight[2] (gms/yr)	No. Corallites (calices/yr)	Height[1] (mm/yr)	Weight[2] (gms/yr)	No. Corallites (calices/yr)
Caryophyllia profunda						
Spec. A	2.02	.57	—	1.15	.32	—
Spec. B	1.55	.42	—	.88	.24	—
Spec. C	1.96	.39	—	1.11	.22	—
Average	1.84	.46	—	1.05	.26	—
Goniocorella dumosa	2.94	.77	—	1.67	.44	—
Culicia australiensis	.46	—	6.35	.26	—	1.12
Tubastrea aurea	—	—	—	—	—	—
Spec. A	1.82	1.16	.47	1.03	.66	.27
Spec. B	3.16	4.50	2.18	1.79	2.52	1.23

[1]Measurements of all specimens are given with the descriptions.

[2]Weight is based upon the dry weight of the cleaned corallum.

Table 2

Summary of Scleractinian Growth Rate Data as deduced from studies of Cable Fauna:

Species	Cable Depth	Cable Location	Cable Age	No. of Specimens	Growth Rate
Caryophyllia electrica[1]	2000-2800 m.	Mediterranean	2 years	10	2.5 mm/year
Lophosmilia telegraphicus[1]	2000-2800 m.	Mediterranean	2 years	1	5.0 mm/year
Lophelia prolifera[2]	—	Off Spain	6 years	–	7.5 mm/year
Desmophyllum cristagalli[3]	1139-1200 m.	North Atlantic	6 years	1	7.1 mm/year
Lophelia prolifera[3]	1139-1200 m.	North Atlantic	6 years	–	6.8 mm/year
Solenosmilia variabilis[3]	1139-1200 m.	North Atlantic	6 years	–	no data
Caryophyllia arcuata[1]	2000-2800 m.	Mediterranean	2 years	1	no data

[1]Data from Milne-Edwards and Haime (1861).

[2]Data from Pratje (1924).

[3]Data from Duncan (1877).

Rates of growth given by Milne-Edwards (1861) for *Caryophyllia* are somewhat greater than those obtained for *Caryophyllia profunda* in the present study. This is not unexpected and probably indicates an excessive age being attributed to the specimens. An additional complication is the fact that at least one of the specimens of *Caryophyllia* is believed to display gerontic characteristics in its morphology, possibly indicating cessation of upward growth. *Goniocorella* has no direct analogies among the Atlantic Ocean corals, but is comparable in growth form to *Lophelia*. There is no comparison in growth rates. The rates obtained for the "shallower" water corals represented by *Tubastrea* and *Culicia* (both have an extensive depth range, but are commonly found in much shallower water than

Caryophyllia or *Goniocorella*) are not as good. Data for *Culicia* are the least reliable of the group, largely because of its growth habit which makes measurements difficult. The two specimens of *Tubastrea* differ considerably in size.

Any conclusions reached through the information given in table 1 must be extremely tenuous. It would seem probable that the age of the specimens is less than the 17 year minimum allowed by the cable history. The *Caryophyllia profunda* are apparently the product of one or two settlements of larvae, possibly representing one- or two-year age classes. In contrast, the two specimens of *Tubastrea* are seemingly of quite different ages, if the growth rates are admissable as criteria for age determination.

SYSTEMATICS

Phylum Coelenterata Frey and Leuckart, 1847.

Class Anthozoa Ehrenberg, 1834.

Order Scleractinia Bourne, 1900.

Family CARYOPHYLLIDAE Gray, 1847.

Genus GONIOCORELLA Yabe and Eguchi, 1932.

Goniocorella dumosa (Alcock), 1902. Figures 1-4.

1902—*Pourtalosmilia dumosa* Alcock, "Siboga" Expedition Monographs: 16a, p. 36, pl. 5, Figs. 33-33a.

A single corallum 88 mm long, 77 mm wide, and 50 mm in height was taken from the cable. The corallum is a dense thicket of elongate, profusely budding corallites which are secured and bound together by extrathecal scalariform processes. Extratentacular budding occurs near the calicular lip, the buds arising from the parent corallite at right angles, soon growing at a lesser angle to the axis of the parent corallite. Calices are consistently 3 to 4 mm in diameter. Septa are non-exsert and are at present in three cycles, arranged in three groups. Septa of the first cycle extend about three-quarters of the way to the centre of the calice, while those of the second are thinner but are about the same length. Third cycle septa are very short. Septa are laterally finely ridged, the ridges not being parallel to the septal margin. The vertical proximal edge of a septum is smooth, sometimes slightly thickened. There is no columella but at depth first cycle septa may loosely mingle. Flat tabular dissepiments are developed at intervals of 5 to 10 mm.

The exteriors of the corallites are covered by fine granulations usually arranged to approximate costae. Fine continuous raised costal lines corresponding to the first cycle of septa are present on most corallites, while older corallites may have costal lines corresponding to the first two cycles of septa. The edge zone of the polyps is extensive, reaching as much as one or two centimetres down the sides of the corallites.

Scalariform processes sent out at irregular intervals to bind the corallum together demonstrate a remarkable directiveness in their construction. The processes are solid rods of extrathecal origin which are apparently formed within rolls of temporary extensions of the edge-zone or coenosarc. Dried tissue present on the corallum before it was cleaned indicated that streamers of the coenosarc must have been sent out as much as 25 mm from the corallites, and that they were not retractable! Secretion of carbonate is apparently stimulated by contact of the

coenosarc extension with some solid object, for process formation is always complete (in observed instances of incomplete construction, the gap was bridged by the coenosarc). In the corallum there are several examples of processes from adjacent corallites meeting end to end and uniting, a disc like pad of carbonate indicating the junction. Processes developed on the lower portions of the corallum bear either fragments of shell or bits of bitumen from the cable at their terminus.

The processes are developed from the calicular lip although construction may continue after the corallite has grown up to a centimetre beyond this point. The solid nature of the processes indicates that they are formed within a fold of coenosarc in the fashion of the solid costal spines of several other caryophyllids, as for example *Stephanocyathus*. The initial portion of the corallum is unknown. The corallum was in contact with the substrate (either cable or sand) at 16 points as indicated by particles of adhering asphalt or shell fragments. None of these contact points were on the corallites, all were on processes. It is possible that the larva which produced the corallum settled upon some bit of sand or shell or soft object, and after a certain amount of development came in contact with the cable.

The development of processes and the general form of the corallum of the specimen at hand are quite different from that figured and described by Alcock (1902). The description of the genus given by Yabe and Eguchi (1932) indicates that processes were present on the specimen before them. The specimen figured by Alcock is quite possibly a fragment, although depth of occurrence and type of substrate may affect the degree of process developments.

Goniocorella dumosa (Alcock) is the only recorded species of the genus although Yabe and Eguchi (1942) list a second unnamed species occuring in shallower water than *G. dumosa* on the Japanese shelf.

Distribution records:

(For *Goniocorella dumosa* (Alcock))

Alcock, 1902, p. 36:

"Siboga" Station 156 0° 29.2′ S., 130° 5.3′ E., 469 m.
259 5° 29.2′ S., 132° 52.5′ E., 487 m.

Yabe and Eguchi, 1936, p. 167:

Off Awasi, Minami-Muro-gun, Mie Prefecture Japan, 100 m.

Yabe and Eguchi, 1942, p. 161:

"Soyo Maru" Station 255 34° 46′ 15″ N., 139° 05′ 00″ E., 263 m.
331 32° 30′ 15″ N., 132° 46′ 20″ E., 344 m.

(For *Goniocorella* sp.)

"Soyo Maru" Station 211 33° 33′ 30″ N., 135° 19′ 00″ E., 190 m.
212 37° 50′ 00″ N., 135° 10′ 30″ E., 181 m.
216 33° 26′ 00″ N., 134° 22′ 00″ E., 274 m.

Genus CARYOPHYLLIA Lamarck, 1801.

Caryophyllia profunda Moseley, 1881. Figs. 5-7, 9-11.

1881—*Caryophyllia profunda* Moseley, Scientific Repts., Challenger Expedition, Zool, vol. 2 pl. 138, pl. 1, Figs. 6, 6a, 6b.

Three specimens of this species were taken from the cable. They are described below in some detail because of the morphological differences in the coralla. These are apparently not all attributable to variation in the corallum morphology, but are indicative of a change in structure with age.

Specimen A: the largest specimen; deposition of stereome within the corallum is apparently responsible for the disproportionately high increase in weight. The costae of this specimen are the most highly developed and most flange-like. The columella is strong and broad, composed of several rows of stout curled laths. Septa of the first group may be lobate at their proximal margin and the pali may be bilobed or trilobed. The septa and pali are coarsely granulate laterally and only septa with pali before them are wavy on their proximal edge. Specimen B: Costae are not as pronounced as in the specimen above, but tend to be broader and more robust. The costae are covered by several rows of relatively fine granules which are aligned in a transverse pattern. The columella is finer, more delicate and narrow, and the septa and pali are not lobate and are more narrow than in specimen A. The septa are finely granulate or smooth laterally, while the pali are glossy smooth. All septa tend to be wavy on the proximal edges. Specimen C: The external ornamentation of this specimen is intermediate between specimens A and B. Septa are lightly granulate, the pali are smooth laterally. Only one septum and one palus are lobate. The columella is composed of a single row of broad laths rather than a bundle of finer ones.

Table 3

Measurements of *Caryophyllia profunda* Moseley.

	Specimen A	Specimen B	Specimen C
Height of Corallum	34.4 mm	26.3 mm	33.5 mm
Corallum diameters	29.8 x 30.0 mm	25.4 x 22.6 mm	23.6 x 21.7 mm
Number of Septa	94	94	80
Number of Pali	22	23	20
Columella diameters	8.0 x 5.0 mm	8.0 x 3.5 mm	5.0 x 2.5 mm
Weight of Corallum	9.7 gms	7.1 gms	6.7 gms
Weight/Height	2.82 gms/cm	2.70 gms/cm	2.0 gms/cm

As noted by Gardiner (1939, p. 337) there is probably a maximum size attained by most solitary corals after which there is little additional growth. The observation is based upon the analogy with growth and sexual development in *Flabellum* (Gardiner, 1902). Cessation of growth in the specimens of *Caryophyllia profunda* from the Norfolk Island cable is indicated by many features of the morphology which are assumed to be gerontic, but is shown more precisely by an increasing ratio of height to weight, although the gross dimensions of all three specimens are nearly the same. Similar measurements upon a large number of specimens will be necessary before this observation can be adequately documented. It is interesting that Gardiner (1939, p. 338) did not anticipate such a development and indeed stated that there would be no proportional increase in weight of corallum with increase in size.

Many instances of morphological variation observed among the solitary corals may be a response to cessation of growth. Characters believed to indicate this condition among the present specimens are increasing coarseness of the lateral ornamentation of septa and pali, lobation of the pali and septa, increase in thickness of septa (and consequent reduction in width of interseptal loculi) and increase in portions and massiveness of the collumella. Certain characters of the external ornamentation may also reflect gerontic development such as coarsening of the ornamentation, thickening of the costae and production of costal flanges. Some of these characters are demonstrated by the

specimens at hand, but frequently they may reflect environmental conditions and therefore are not trustworthy. The sequence of specimens from the cable show the development of these gerontic characters well. Specimen "C" can be considered as the "youngest", while "A" is the "oldest".

Distribution records for *Caryophyllia profunda* Moseley:

Moseley 1881, p. 139:		
"Challenger"	Station 135	Off Nightingale Island, Tristan da Cunha Group. 100-150 fathoms
Gardiner, 1929, p. 126:		
"Terra Nova"	Station 91	Off Three Kings Islands, New Zealand. 300 fathoms.
Gardiner, 1939, p. 331:		
"Discovery"	Station 6	Tristan da Cunha, Quest Bay, 80-140 m.
	Station 1187	S.E. of South Hill, Inaccessible Island, Tristan Group, 117-140 m.

Family RHIZANGIIDAE d'Orbigny, 1851.

Genus CULICIA Quoy and Gaimard, 1833.

Culicia australiensis Hoffmeister, 1933. Fig. 8.

1933—*Culicia australiensis* Hoffmeister, Biol. Res. Fishing Exper. F.I.S. "Endeavour", 1909-14: 6 (1), 12, pl. 3, Figs. 3-4.

A single specimen consisting of 21 corallites spread upon a mat of polyzoan and indeterminate material seems most closely allied with this species. As remarked by Wells (1954, p. 464) the species of *Culicia* are in need of revision but can be grouped according to the nature of septal margins, and the number of septa. *Culicia australiensis* is characterized by the possession of nearly four complete cycles of septa, the first and second cycles being subentire, usually exsert. Higher cycles of septa are progressively more highly dentate. In this respect, the species is most closely allied with *Culicia truncata* Dana from which it differs in not having the first cycle septa notched next to the wall.

Distribution records for *Culicia australiensis*.

Hoffmeister, 1933, p. 12:

Off Marsden Point, Kangaroo Island, South Australia. 17 fathoms.

Table 4

Measurements of *Culicia australiensis*.

	Corallites				
	A	B	C	D	E
Diameter of corallites	5.0 mm	5.0 mm	3.75 mm	3.5 mm	4.0 mm
Number of septa	38	38	38	33	41

Family DENDROPHYLLIDAE Gray, 1847.

Genus TUBASTREA Lesson, 1834.

Tubastrea aurea (Quoy and Gaimard), 1833. Fig. 12.

1926—*Dendrophyllia aurea* (Quoy and Gaimard), van der Horst, Trans. Linnean Soc. London, ser. 2, Zool.: 19, 46, pl. 2, Figs. 1-4, 8, 9.

Van der Horst has discussed the synonymy of this species and I can add nothing. The growth form of the specimens from the cable is typical of young specimens of this species. A spreading mat of peritheca

serves as a basis for initial upward growth. Lateral budding soon covers this mat with young calices and the form of the corallum becomes hemispherical. *Tubastrea* is typically a rock coral found usually in shaded areas in shallow waters and to a considerable depth of water, but always attached to a fresh rock surface, or some other hard bit of substrate. The distribution of *Tubastrea aurea* is circumtropical.

Table 5

Measurements of two specimens of *Tubastrea aurea* (Quoy and Gaimard):

	Corallum A	Corallum B
Weight of corallum	19.7 gms	76.1 gms
Maximum diameter of corallum	56.7 mm	65.8 mm
Height of corallum	30.8 mm	53.7 mm
Number of corallites	8	37

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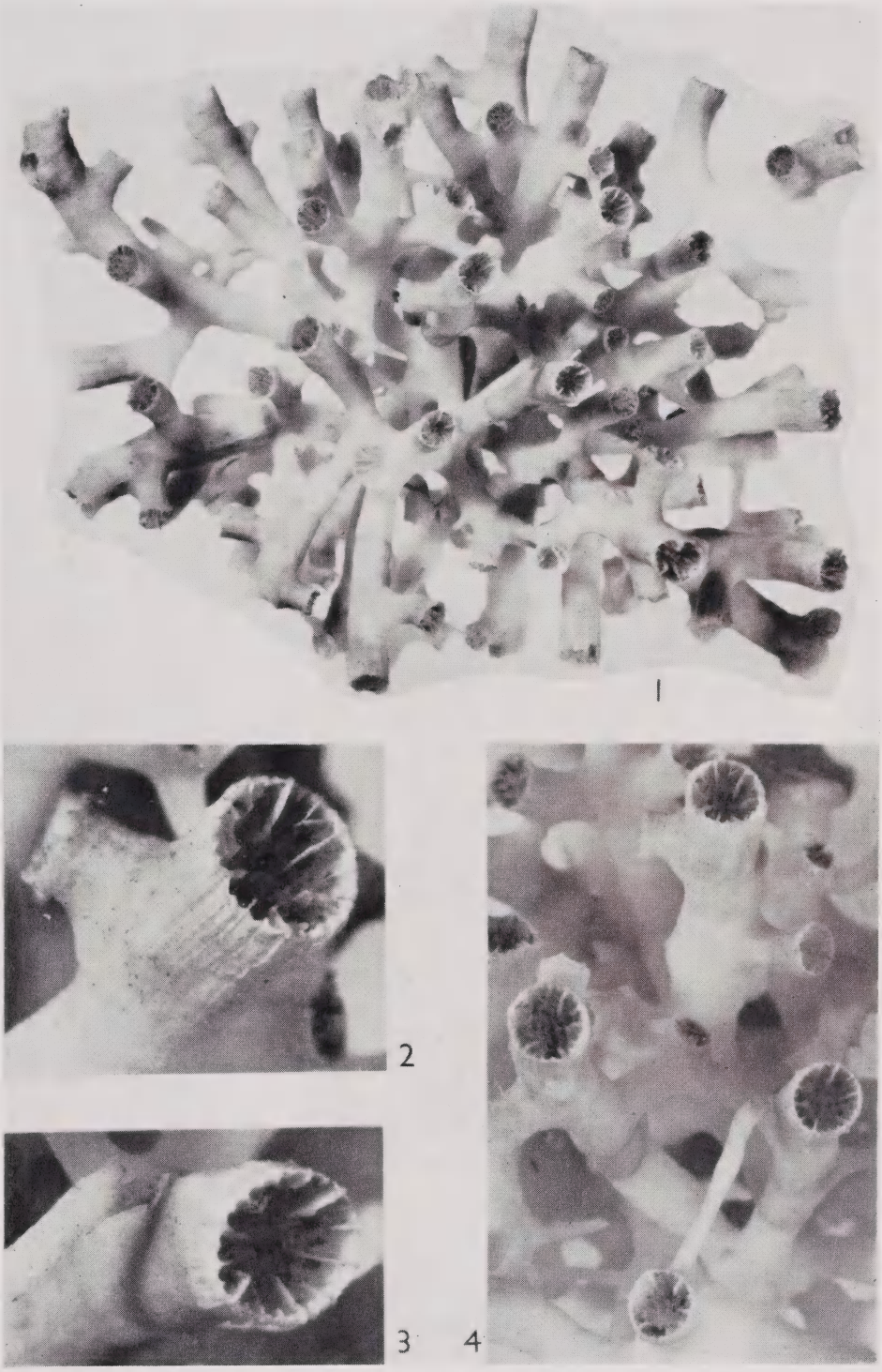
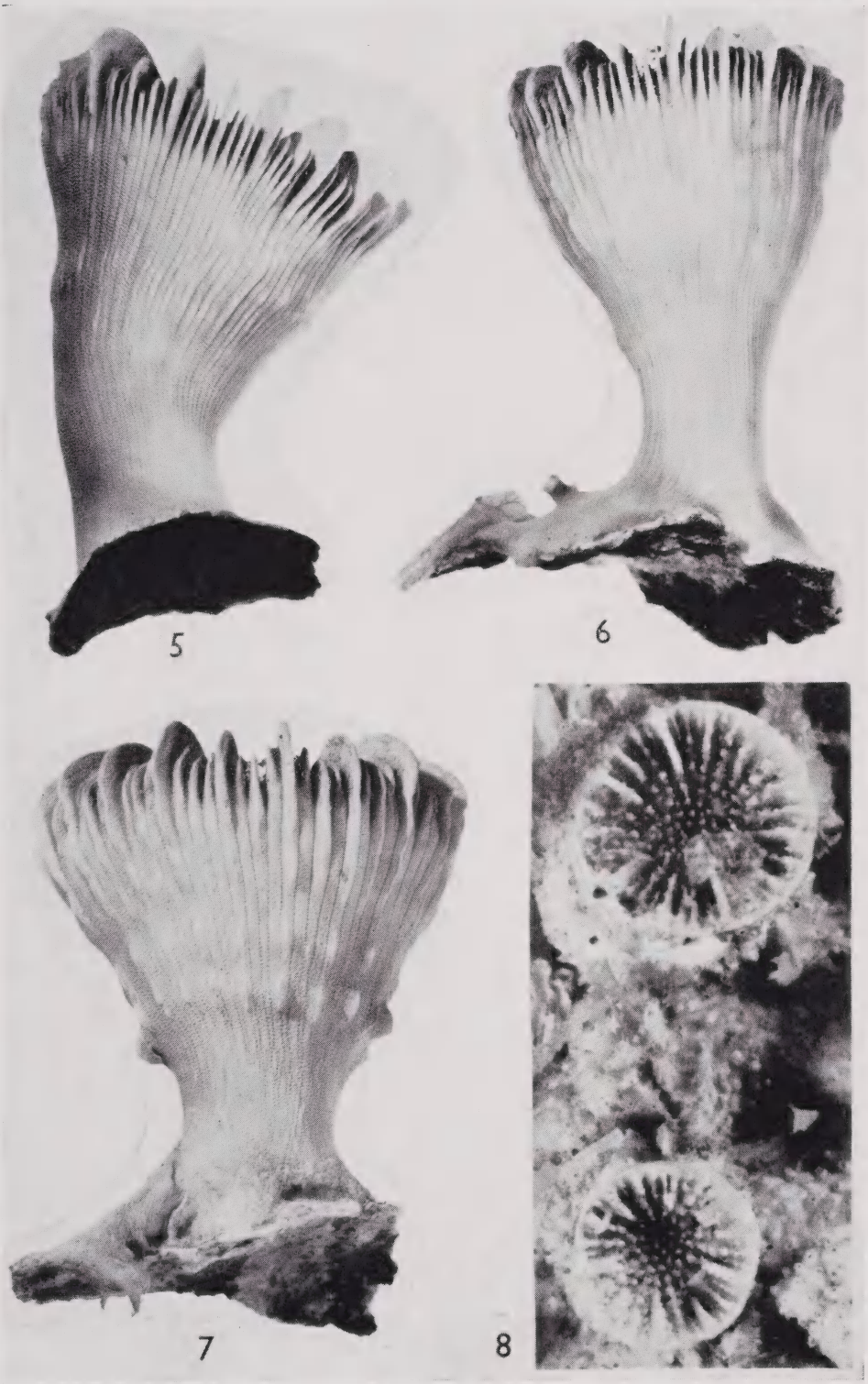
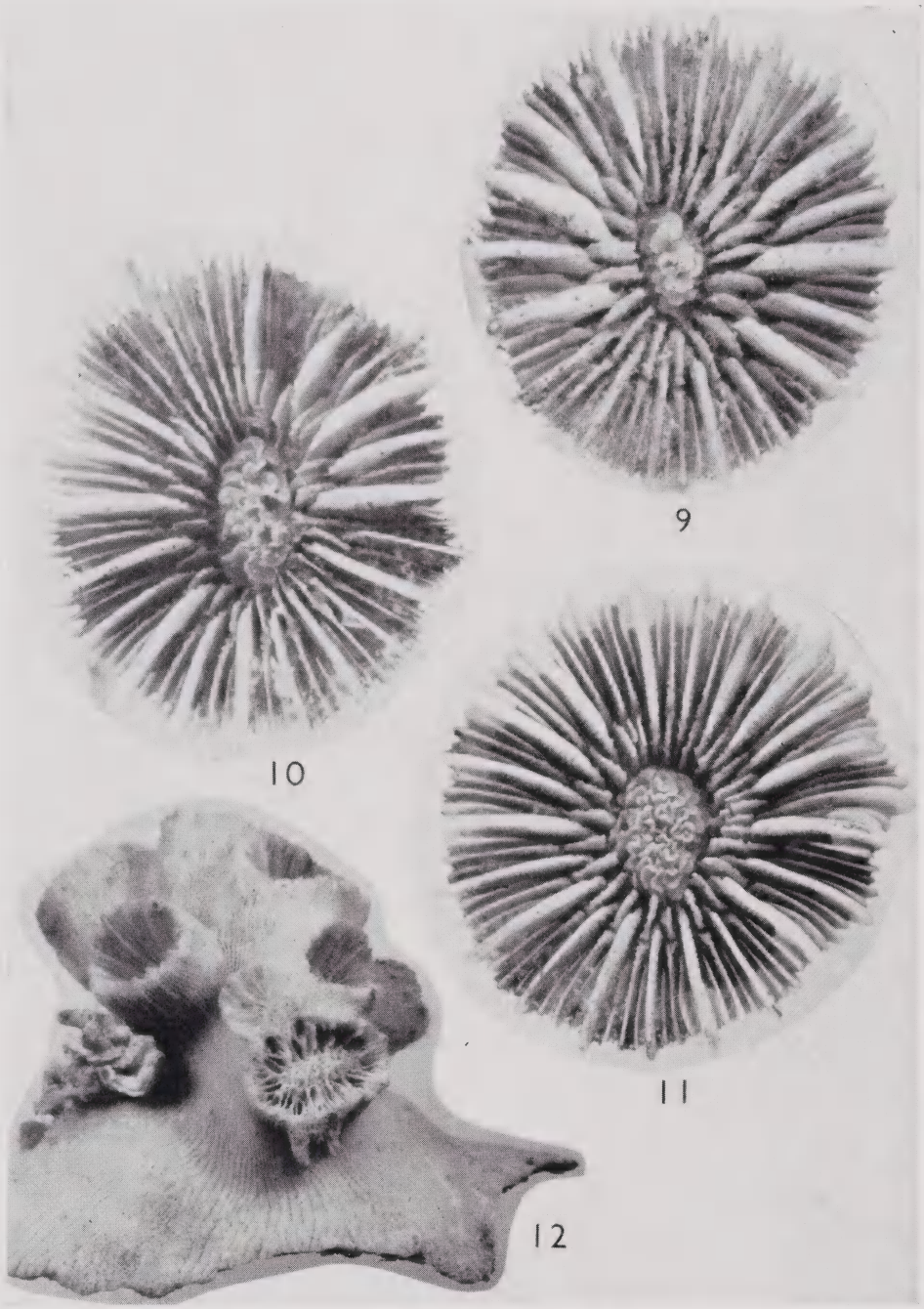


Figs. 1-4. *Goniocorella dumosa* (Alcock). (Fig. 1.) Corallum, x 1.4. (Fig. 2.) Calice, x 10.4; note costae and fine granules approximating costae. (Fig. 3) Calice and process, x 10.4; showing disc-like pad where process attaches to corallite. (Fig. 4.) Calices and process, x 5.2.



Figs. 5-7. *Caryophyllia profunda* Moseley. (Fig. 5.) Specimen B, x 2.0. (Fig. 6.) Specimen C, x 2.0. Notice slight development of flanges on costae. (Fig. 7.) Specimen A, x 2.0. Notice massive appearance of septa and costal ornamentation.

Fig. 8. *Culicia australiensis* Hoffmeister. Corallum x 7.0.



Figs. 9-11. *Caryophyllia profunda* Moseley. (Fig. 9.) Specimen C, Calice, x 2.5, showing lightness of construction. (Fig. 10.) Specimen B, Calice, x 2.5. (Fig. 11.) Specimen A, Calice, x 2.5.

Fig. 12. *Tubastrea aurea* (Quoy and Gaimard). Smaller specimen, approximately x 2.0.